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EVALUATION OF THE EFFECT OF ASBESTOS IN INDUSTRIAL CONDITIONS

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(Recommendations of the Subcommittee on Asbestos of the Standing Committee and and the International Association on Occupational Diseases)

The extensive use of asbestos in industrial goods and in products of wide consumption and the spread of occupational diseases, especially asbestosis and tumors connected with the excessive effect of asbestos fibers in the air, have served as an impetus in the last ten years in many countries for numerous studies to learn the effect of asbestos on the body and for the development of standards and environmental control. Methods of enumeration and characterization of the effect of inhaled asbestos fibers used in different countries differ significantly from each other, making it extremely difficult or generally impossible to compare and exchange seemingly similar data. The significance of studies conducted throughout the world on asbestos would be much greater if the same means of sampling, enumeration and characterization of the effect of inhaled asbestos fibers were used. This would make it possible to exchange information among countries and create a common data bank, thereby increasing the volume, reliability and usefulness of information.

The Subcommittee on Asbestos of the Standing Committee and the International Association on Occupational Diseases recommends the following methods of sampling, enumeration and characterization of inhaled asbestos fibers in the industrial atmosphere.

A. Methods of evaluating the effect of asbestos fibers

1. Air sampling. The membrane filter method must be used to sample asbestos fibers in the air. The respirable fraction[1] must be used to measure characteristics in order to compare levels of the effect of asbestos on the body as well as to determine conformity to standards.

Special methods recommended for sampling asbestos fibers in the air with a membrane filter, including characterization of the equipment and the sampling

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[1] In the opinion of Soviet researchers it is also necessary to take into consideration the so-called nonrespirable fraction of dust particles (over 5-7 μμ) which has a harmful effect on upper respiratory passages. — Ed.

were developed for the Asbestosis Research Council in England and the National Institute of Occupational Diseases in the USA. These methods are described in "The Measurement of Airborne Asbestos Dust by the Membrane Filter Method"[1] and "The Method Used by the U.S. Public Health Service for Enumeration of Asbestos Dust on Membrane Filters."[2] Both of these methods give comparable results.

2. Sampling area. The purpose for which a sample will be used determines not only its type, but also the place where it is to be taken. Air samples taken from the breathing range of workers are to be used to obtain data on the effect of different amounts of asbestos on the body as well as to evaluate conformity to standards. These samples can be obtained with individual samplers by the workers themselves or by an operator holding sampling equipment near the breathing range of the workers. Samples taken continuously in the same places can be used to obtain data on the effectiveness of dust control equipment.

3. Sampling time. In taking samples of asbestos dust in the air, the time needed will depend on the rate of sampling by the instrument, the relative concentration of dust in the air and the purpose for which the sample is being taken. A relatively short sampling time and frequent samples are necessary to determine intermittent maximum levels of effect. In contrast, a longer sampling time is required to determine weighted mean levels of effect. Obtaining data on levels of effect in order to establish their correlation with changes in health, as well as to determine conformity of existing concentration to the standard requires not only brief, but also prolonged sampling. In some cases the directions indicated both sample taking instruments and the time needed for sampling.[3] The time for each sample and the number of samples taken in any given operation are to be such as to insure reliable data to achieve the purpose for which the samples were taken.

4. Fiber count. Although specific etiological agents which cause diseases in cases of the excessive effect of asbestos dust are unknown, the best generally accepted index is the number of inhaled fibers present in the

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[1]Technical Note 1. The Measurement of Airborne Asbestos Dust by the Membrane Filter Method. Asbestosis Research Council, P. O. Box 40, Rochdale, Lancashire, England.

[2]The Method Used by the U.S. Public Health Service for Enumeration of Asbestos Dust on Membrane Filters, by G. H. Edwards and J. R. Lynch, U.S. Department of Health, Education and Welfare, Public Health Service, 1014 Broadway, Cincinnati, Ohio, 45202.

[3]Technical Note 2. Dust Sampling Procedures for Use with the Asbestos Regulations, 1969. The Asbestosis Research Council, P.O. Box 40, Rochdale, Lancashire, England.

breathing range of the workers. It would be impossible to count all inhaled fibers, as many of them measure less than a micron and an electron microscope would be needed to determine the number. The use of this method in every-day practice would be too expensive and time consuming. Therefore, at the present time, as an index of the general spectrum of effect only inhaled fibers which can be detected by an optic microscope are counted.

On the basis of accumulated experience, it is customary to designate as a fiber a particle in which the ratio of length to diameter is equal to or exceeds 3:1. Calculation results are to be expressed by the number of fibers per cubic centimeter (or millimeter) whose length is less than 5 μ. Fibers which are more than 5 μ in diameter are to be excluded, as they are chiefly not respirable. Asbestos fibers are to be counted in a phase contrast microscope with magnification approximately 400-500 times. Preparation of the membrane filter, on which asbestos fibers settle, as well as the method of counting fibers with a microscope are described in the publications "The Measurement of Airborne Asbestos Dust by the Membrane Filter Method" and "The Method Used by the U.S. Public Health Service for Enumeration of Asbestos Dust on Membrane Filters". Both methods give comparable results.

Also necessary for scientific purposes is a limited volume of measurements of fibers in samples on membrane filters using optic and electron microscopy to establish the ratio of fibers longer or shorter than 5 μ as well as the relative distribution of diameters of the particles. These measurements are necessary as the biological significance of asbestos fibers less than a micron in size is basically unknown and fibers 5 μ long or more are not always a reliable indication of effect reflecting the significance of the spectral distribution of inhaled fibers.

To evaluate the degree of danger and determine conformity to existing standards, as well as for scientific purposes, it is recommended that the ratio of asbestos fibers to the total number of inhaled particles be ascertained. This is especially important in those cases when other inhaled particles can be biologically active in themselves or can intensify the effect of asbestos as well as when the number of fibers is relatively small so that standards (norms) for other inhaled materials present acquire decisive significance.

B. Chemical characteristics of fibers

1. Type of fibers. Different types of asbestos fibers, depending on their chemical and physical characteristics, can cause different biological reactions. It is necessary to identify the type of asbestos present in inhaled fibers, for example, chrysolite, amosite, crocidolite, etc., and this information is to comprise part of the data on the level of effect of asbestos fibers. This identification can be relatively simple if the nature of the basic mass of asbestos forming the dust is known. However, in some cases a natural mineral such as talc can contain a mixture of fibers. In addition,

the source and nature of the asbestos represented in the sample can be unknown. In such cases determination of the nature of the fibers can require polarization microscopy, x-ray diffraction, electron microscopy, electron microsounding, electronography or other special methods.

2. Metals. Sometimes asbestos fibers are combined with metals which can be biologically active. These metals can be the result of mineralogical processes connected with formation of the fibers or with the abrasive effect of fibers on metal alloys during the treatment process. The number of individual metals present in a sample of inhaled dust can differ greatly from the metal content in the main mass of material or in samples of settled dust. For scientific-research purposes,representative samples of inhaled asbestos dust, taken during typical production operations, must be analyzed with determination of biologically active metals, for example, nickel, chromium, cobalt, magnesium, iron, etc. A sufficiently sensitive method must be used to determine accurate concentrations on the order of micrograms per 1 m^3 of air.

3. Free silica. Some types of asbestos fibers can contain large amounts of free silica. Sometimes it is added to asbestos products such as graveled pavements, sheathing material and ducts. In evaluating the level of effect of asbestos to which workers are exposed, it is necessary to measure the concentration of free silica in those industrial operations when it can be present in the air in amounts approaching the standard of effect of silica.[1]

4. Organic contaminants. Samples of inhaled asbestos dust can contain different amounts of polycyclic aromatic hydrocarbons, depending on the nature and source of the asbestos fiber, the treatment process, the packing process as well as the absorption of organic compounds from surrounding air. For scientific purposes,the concentration of extracted materials must be determined in cyclohexane samples of inhaled asbestos dust, collected on fiberglass filters under industrial conditions. Where possible,high-performance samplers are to be used in order to determine amounts of usually-encountered polycyclic aromatic hydrocarbons in the samples.[2]

C. Physical characteristics of fibers

The external form of inhaled asbestos fibers under the microscope can sometimes be distinguished from those normally found (for example, twisting of the fibers, enlarged sections within fiber bundles, etc.). For scientific purposes it is necessary to record these peculiarities of the microscopic picture and their frequency.

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[1]American Conference of Governmental Industrial Hygienists. The Threshold Limit Values of Airborne Contaminants and Intended Changes (1970).

[2]In particular, benz(a)pyrene. — Ed.

D. Alternative methods of evaluating the effect of asbestos

1. Particle count of asbestos dust. Many years experience using special methods such as konimetry, projection microscopy in a light field, etc., to collect and measure asbestos dust in determination of the level of effect have been accumulated in many countries and extensive knowledge has been obtained with regard to the correlation of these data with the influence on human health. It is important that this knowledge not be wasted and a clear connection be established between previously accumulated data and analogous material, obtained with the application of unified methods recommended by the Subcommittee on Asbestos. Therefore, the Subcommittee is insisting that countries not using the recommended methods in every-day practice start to use them along with their usual methods of collecting and measuring asbestos dust. As a result, it will become possible to obtain comparable data.

2.Other methods. Other methods selectively used for measurement and characterization of inhaled dust in connection with the effects of asbestos include the use of dust meters with direct and indirect readings, gravimetric measurements, determination of the surface, etc. The use of these methods of calculation and characterization of dust particles is to be encouraged, as this can help reveal new knowledge about biological reactions to the effect of fibers. However, the Subcommittee on Asbestos insists on obtaining parallel data using their recommended methods.